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ABSTRACT

E-learning leads to changes in the way courses are conceived. Diffused through the Web, course content cannot be the pure transcription of a "classical" course. The students need to personalize it and to access it when they need it (just-in-time). The MEMORAe project aims at applying knowledge management techniques to improve the structure of the content and its access in e-learning solutions. The authors propose to build an ontology-based learning organizational memory and to give the users direct access to this memory by using knowledge books. The pilot application was a course on algorithms and programming attended by beginner students in a technological university in France. (Contains 15 references.) (Author/AEF)

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E-Learning and Knowledge Management: the MEMORAe Project

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Abstract: e-learning leads to evolutions in the way of conceiving a course. Diffused through the web, the course content cannot be the pure transcription of a "classical" course. The students need to personalize it and to access it when they need it (just-in-time). Therefore the course content is often divided into knowledge grains. The MEMORAe project aims at applying knowledge management techniques to improve the structure of the content and its access in e-learning solutions. We propose to build an ontology based "learning organizational memory" and to give the users a direct access to this memory by using "knowledge books". The pilot application we chose is a course on algorithms and programming attended by beginner students in our technological university.

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Introduction

Information Technology has already transformed the way we work and has a growing impact on the way we learn. New approaches mainly based on the utilization of web technologies are proposed. These approaches are often grouped under the concept of "e-learning", which is still unclear but often put forward as a key-solution to professional training difficulties. Indeed, e-learning allows on-site training and can contribute to a closer integration between working and learning situations. However it raises also many problems and its progression is slower than one could at first think.

A key point in building an e-learning solution is to give the users an easy access to the contents and to the resources they can use. To this end, knowledge is often cut up into grains (Boullier, 2001), joining in that knowledge management techniques. More generally our goal in the MEMORAe project is to study the possibility to apply knowledge management techniques to the construction of e-learning solutions. We propose to build an ontology based learning organizational memory and to make it available to students in an e-learning context.

As a pilot application, we chose a course on Algorithms and Programming, which is taught at the Technological University of Compiègne (France), in face-to-face as well as in distance education. Before describing this project in details, we first clarify our conception of e-learning and we argue for making the link between knowledge management and e-learning.

From Training to E-Learning

E-learning brings some new characteristics regarding to classical training situations. First of all, using the term e-learning rather than e-teaching sets the focus on the learner. In e-learning situations, the learner has to be more active than in classical training applications. Knowledge is not presented linearly as in a course. It is often divided into grains and the user has to choose the grains he considers as being useful for him. He can be helped in this task by a tutor. Teachers and learners roles are deeply modified: learners have to be more active and can cooperate with other learners, teachers play the role of tutor and have rather to assist students than to deliver their knowledge. The tutor pedagogy is based on the personal work of the student.

To sum up, we consider an e-learning application as being a distance learning application

- Using a network approach,
- Giving access to contents divided into grains and not to a linear course,

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- In which students are active and can work in a collaborative way,
- In which teachers role is rather to assist students than to deliver their knowledge.

This definition puts the emphasis on the contents provided to students. It presupposes pedagogical resources to be precisely described in order to allow the students to easily access them, with the help of the tutor if needed. The contents elaboration is a quite complex and time-consuming operation that can rarely be realised by the only tutor. Moreover an e-learning application has to allow the management of all the relations, contents and technologies. It implies to identify the expertise in the course organisation itself.

Knowledge Management and E-Learning

In an e-learning application we find people (learners, teachers, administrators, etc.) who need to communicate and to access knowledge and information when they need it ("just in time"). This kind of situation has some similarities with a knowledge management situation.

Knowledge management aims at formalizing knowledge in order to share it and to reuse it. The process of knowledge management involves the following actions (Benjamins et al., 1998):

- gathering the knowledge to be managed,
- organizing and structuring the knowledge,
- maintaining knowledge,
- bringing the knowledge to the persons who need it.

A way to fulfill these requirements is to conceive a corporate memory or more widely an organisational memory. Following (Barthès et al., 1999) an organizational memory is an explicit and persistent representation of knowledge and information in an organization, in order to facilitate their access and re-utilization by adequate members of the organization.

The implementation of an organizational memory may vary according to its expected utilization. It often uses a database, a knowledge base or a document indexing system. The design methods vary according to the available sources: human experts, paper or digital documents etc. A frequently adopted solution to design and manage an organizational memory is to use ontologies.

In knowledge engineering a commonly used definition of an ontology is the one of Grüber (1993): "an ontology is an explicit specification of a conceptualization". By "explicit specification", Gruber means that the ontology is coded with a language. This language can either be the natural language or a logical language.

Roughly an ontology can be represented as a hierarchy of concepts augmented by a definition of the relations between the concepts and by rules and constraints (Fortier, 2001).

In our project, the elaboration of an ontology will be useful to structure the learning contents and to define a shared vocabulary. The ontology will allow to add a context to the requests and to facilitate the access to the information thanks to the semantics associated to the concepts.

Learning Contents Management: the MEMORAe Project

The MEMORAe project focuses on the contents management in an e-learning application. We consider this issue as a knowledge management issue involving acquisition, gathering, organization, maintenance and distribution of the learning knowledge. We are building what we call a "learning organizational memory" (Fig. 1). Users (learners, teachers, tutors, etc.) have access to any capitalized information related to the course they have chosen: pedagogical objects (Bourda & Hélier, 2000), learning objects (Boullier, 2001), users descriptions, etc. Moreover they can communicate and collaborate through the memory. The memory is built and structured by the way of ontologies.

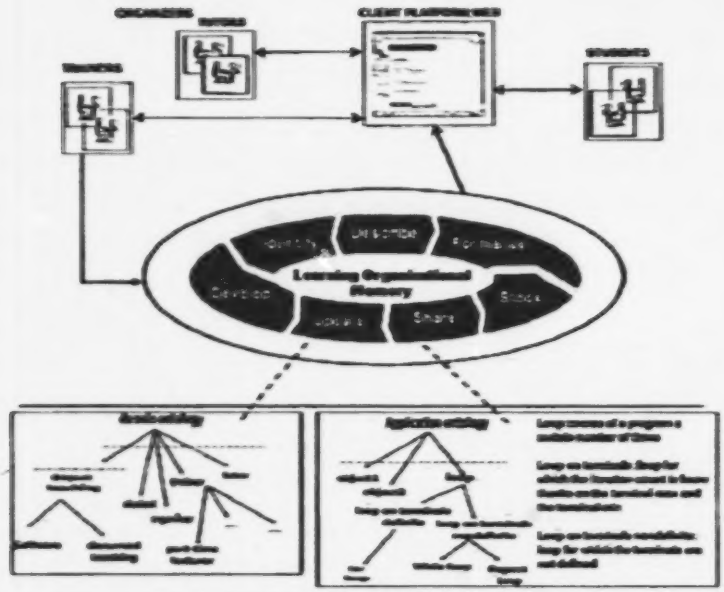

Figure 1: the MEMORAe Project.

We present below the course that we have chosen as a pilot application. We precise the distinction between learning objects and learning contents. Then we describe the learning organizational memory contents and structure. Finally, we explain how we materialize and diffuse this memory.

Choice of an Application : NF01

In the MEMORAe project, we consider scientific teaching at university. The pilot application we have chosen is a course attended by young students (first year at the technological university of Compiègne). This course, which is often referred to by its code NF01, is a course on "Algorithms and Programming", delivered in face-to-face education (250 students) as well as in distance education (25 students). This course combines theoretical and practical teaching. Its goal is not to learn Pascal programming but to learn programming itself. The Pascal language is only introduced to practice notions on algorithms.

Learning Objects and Learning Contents

Developing a course diffused through the internet implies to set the pedagogical focus on the student. The goal is to make him/her active, to give him/her a clear view of the available resources, and to learn him/her how to seek and use them. The articulation of a course around learning objects offers many learning individualization possibilities. According to Boullier (2001), such a division of the "knowledge world" is a preliminary act, needed in any teaching process. Boullier sees this division as materialized by the supports. Learning objects are the result of a delimitation of texts, a semantic marking up (Bachimont & Charlet, 1998). Contrary to this work, we do not consider a learning object as being a piece of a linear course text, but as a notion to be learnt. Thus, it is not necessary to build any support materializing such a delimitation. Authors remain free concerning the creation of their learning support, for example they do not have to follow any graphic charter. Learning objects (notions to be learnt) index documents related to them.

Within the framework of the MEMORAe project, we represent not only learning objects but also other types of knowledge such as documents and information related to these objects. Our choice of representing learning objects as notions (concepts) that allow to index documents related to them gives more flexibility to the writing of documents and allow the reuse of various types of documents. The fact that a learning object references many documents allows many ways to get it.

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The course manager is responsible for the quality of the teaching content, he defines learning objects and selects documents to be indexed. Among learning objects, we can also find problem-situations (what to do in such situation ?). The tutor is in charge of the construction of the teaching scenario.

Content of a Learning Organizational Memory

A learning organizational memory allows to capitalize not only learning objects but also any knowledge, documents, information related to them. The organizational memory we build does not capitalize the whole documents and knowledge related to the NF01 learning objects but a pertinent part according to the course manager.

Beyond the pedagogical content, the memory capitalizes:

- Any information related to the learning environment that can be useful to users: trainers, staffs, entry form, learners, etc.
- Users knowledge.

Within the framework of e-learning, the student has to be active and to access to different types of information. The need of a shared vocabulary between the actors of the educational process is thus reinforced. In order to define this shared vocabulary within the memory, we propose to develop an ontology, more exactly several ontologies:

- A domain ontology of learning: it defines concepts of the learning domain, concepts which remain generic for this domain. In such an ontology we find for example concepts like: coach, tutor, secretary, as persons, or book, learning device as documents.
- An application ontology: it defines concepts of a particular application, and contains concepts definitions more specific than those of the domain ontology. For example, concerning an ontology about algorithms, concepts such as loop or array are defined. An application ontology has to be defined for each course considered. It's through this ontology that the learning objects are determined.

These ontologies are part of the organizational memory, in other words they structure it. In addition to them, the memory contains various documents related to the course. These documents are at least represented in the organizational memory, some of them are directly stored in the memory.

Materialization of a Learning Organizational Memory

Starting from the necessity to exploit the web to realize an e-learning application, we made the choice of materializing our organizational memory by the way of computing structures:

- a knowledge base to represent knowledge and receive ontologies,
- a documents base to store various electronic documents indexed by knowledge.

Diffusion of the Organizational Memory

The organizational memory we build consists in ontologies and electronic documents. The memory user has to interrogate concept representations to reach the needed information. In order to give him this possibility, we chose to use the concept of knowledge book (Ermine et al. 1996, Kassel et al. 2000, Abel et al. 2000) which represents a knowledge base consulting environment.

Navigating through a knowledge portal that is unknown is often a difficult task. If the portal is well structured, it is usually more helpful for the user to explore it by browsing (Staab & Maedche 2001).

The knowledge book is a document which allows to consult knowledge represented in a knowledge base. This book differs in several points from classical portals. On one hand, its content and its presentation are generated starting from the knowledge base. On the other hand, its structure is still the one of a classical book augmented of IT functionalities. According to Boullier (2001), the stability of the workspace constitute a cognitive framework, particularly useful when there is no interaction allowing to adapt one by one common marks like in a face-to-face teaching.

The knowledge book is an hypertextual document: links allow to navigate within different representations and to make actions relying on these representations, for example, reaching electronic documents of the memory or sending an email to a person.

The knowledge book consists in two frames (Fig. 2). The static left frame presents different parts of the book to the user. These parts concern the learning contents and are chosen by the course manager. The dynamic right frame displays the content of the selected part. These two frames allow to read the knowledge book in two ways: a "predefined way" and a "free way", with the possibility to shift from one to the other at any time.

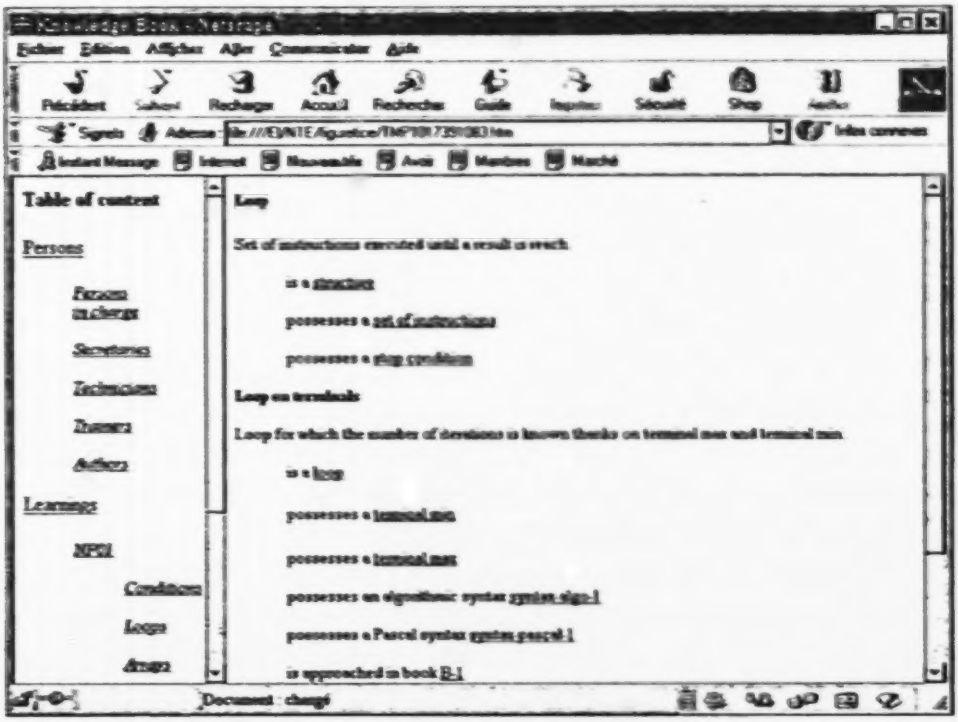

Figure 2: a Knowledge Book.

The "predefined way" is made possible by the way of the left frame. Indeed, as in a traditional book, the user is guided by the structure of the book. The only difference is in the possibility to directly access the different parts of the book by using the mouse.

The "free way" consists in browsing through the ontology presented in the right frame. It gives the possibility to reach a given knowledge piece in different ways: by browsing through the hierarchy of concepts or by browsing through links between knowledge pieces in the memory (e. g. "Loop is approached in Book B1").

Electronic documents of the organizational memory are represented in the knowledge base as object models representing instances of concepts defined in the sub-ontology of documents. They are stored in a documents base. The knowledge book allows to diffuse objects models of the knowledge base (Fig. 2). Starting from the representation of these models, the users can reach stored electronic objects. Indeed, if the user wants to reach a document itself and not its representation, (s)he can do that by the way of a contextual menu that allows him/her to execute different actions on the knowledge representation, for example "reach an electronic document".

Thus, whatever the knowledge is, its access and presentation are always done in the same way. So, we obtain a coherence in knowledge presentation formats and users can find new handling ways.

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Conclusion

We focused in this paper on content management in e-learning applications. We consider that it is a knowledge management issue involving acquisition, gathering, organization, maintenance and distribution of learning knowledge. We propose to design an ontology-based "learning organizational memory" that will be made available to the actors of the educational process. This memory capitalizes the notions students have to learn and all the needed related information. The knowledge grains representation relies on an ontology. These grains are used as an index to access various related documents and information.

By using ontologies, our goal is also to define a vocabulary common to all the actors involved in the learning process. This common vocabulary is particularly needed in a distance context. In the evaluation of the learning organizational memory we plan to make we will particularly examine to what extent this vocabulary can be shared by learners and tutors. Furthermore through our pilot application we will evaluate how the memory can help a student to build its own personalized course.

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